LAKE VICTORIA ENVIRONMENTAL MANAGEMENT PROGRAM

FISH BIOLOGY AND BIODIVERSITY CONSERVATION SUB-COMPONENT

PROCEEDINGS OF THE REGIONAL WORKSHOP ON HARMONIZATION OF TERMS OF REFERENCE FOR REGIONAL CONSULTANCY 28 – 29 MAY 2001, JINJA, UGANDA

HOST: **Fisheries Resources Research Institute Fish Biology and Biodiversity Conservation Sub-Component.**

ACRONYMS

DO	-	Dissolved oxygen
FIRRI	-	Fisheries Resources Research Institute
GIS	-	Geographical Information Systems
KMFRI	-	Kenya Marine & Fisheries Research Institute
LVEMP	-	Lake Victoria Environmental Management
MSC	-	Master of Science
PHD	-	Doctor of Philosophy
RV	-	Research Vessel
TAFIRI	-	Tanzania Fisheries Research Institute
TOR	-	Terms of Reference

PAGE

1.0 SUMMARY

The regional harmonization workshop on the terms of reference for consultancies was held from 28th – 29th May 2001 at FIRRI Jinja, Uganda. Component coordinators and Task coordinators (Kenya, Uganda and Tanzania) attended the workshop as well as scientists from Uganda undertaking thematic areas of the sub-component activities.

Country briefs on project implementation status were presented. Modalities for cross border sampling and a regional sampling schedule for satellite lakes were set up. Areas that need consultancy were identified and allocated to each country for coordination according to their priority with no charge in the terms of references. Kenya and Tanzania to start a write-up for the two books and a workshop to facilitate this activity was scheduled for January 2002

2.0 OBJECTIVES

1. National progress briefs including highlights of the recent World bank review mission.
2. Regional sampling of satellite lakes.
3. Trans border sampling.
4. Consultancy requirement and lime frame for consultancy.
5. Preparation of the two books.

3. WORKSHOP PROCEEDINGS

3.1 0PENING REMARKS FROM THE CHAIRMAN: DIRECTOR FIRRI DR. R.OGUTU OHWAYO

The chairman opened the workshop by welcoming the participants to the meeting after noting that the participants from Tanzania were stranded in Nairobi due to flight delays and were expected later in the day. It was agreed that the meeting proceeds without the team from Tanzania. He requested the workshop be extended to Wednesday 29th may 001 since one day was not enough for the discussion of workshop proceedings and in order to accommodate the Tanzanian delegation The chairman noted that the articipants did not know each other and therefore requested them to introduce themselves. (Annex 4 i) The Tanzanian delegation arrived on the 29th and participated during the last day of the workshop.

3.2 ADOPTION OF THE WORKSHOP PROGRAMME

The chairman outlined the agenda for the workshop (Annex 4 ii) for comments or amendments from the participants. No comments were raised on the agenda. The agenda was proposed for adoption by Mr Mutune Masai, from Kenya and seconded by John Balirwa from Uganda. It was adopted without any amendment .The three task coordinators were nominated as rapportours for the workshop.

3.3 INTRODUCTION OF THE WORKSHOP BY THE REGIONAL SUB-COPONENT LEADER, DR.ENOCK WAKWABI , DEPUTY DIRECTOR – KMFRI.

The regional sub-component leader Dr. E. Wakwabi, noted that he joined the project recently and he was fast catching up with the project activities He noted that the progress of achieving the sub- component objectives especially for Kenya had been hampered by lack of funds during the initial stages of the project implementation. However since the flow of funds had improved he was optimistic that the sub-

component will successfully address its objectives within the remaining tenure of the project.

This is the last year for the project; however some of the agreed areas of the project for example, the consultancies, were not yet in place. He noted that there was need to evaluate whether it was necessary to carry out such activities have it at this time now that there was only one year to implement the project .He observed that consultancies required funds and wondered whether such funds would be made available in time.

He appreciated the convening of this workshop and noted that it had provided a forum to discuss issues that had been pending for a long time. The results of this workshop will be a starting point for the next phase of the project since it had been envisaged that the project would be extended for a period of two more years. He concluded his comments by welcoming the participants and urged them to deliberate freely for the success of the workshop

3.4 ORIGINAL OBJECTIVES: FISH BIOLOGY AND BIODIVERSITY SUB-COMPONENT

Dr. Ogutu-Ohwayo outlined an overview of the sub-component's original objectives. (Annex 4 iii) He suggested that country progress briefs would be guided by this outline Each country was therefore called upon to summarize the activities/achievements etc under each objective as outlined in the logistical table below.

3.3 COUNTRY BRIEFS ON PROJECT IMPLEMENTATION STATUS

Objectives	Uganda	Kenya	Tanzania
a) Identify the main factors affecting aquatic biodiversity and recommend means of managing them	Data available on physico-chemical variables – secchi depth, DO, Chlorophyll a concentration, pH, and conductivity. Recommendations are available Introduced species, destructive fishing gears and methods, pollution were identified as the main factors affecting biodiversity;	Identified destructive fishing gears and methods, identified sources and levels of pollution and impacts of introduced species i.e. the Nile perchas major factors. Recommendations were made to confiscate destructive gears. Other issues are being addressed by other sub-components under LVEMP	Data have been collected on various physico-chemical parameters (pH, nutrients, etc), fishing gears and methods, species composition, population structure, and food and feeding habits. 1 MSc has been completed on pollution of heavy metals on *O. niloticus*
b) Make an inventory of existing and threatened aquatic biodiversity and map out habitats where these species are surviving (satellite lakes, rocky / macrophyte refugia etc.)	Inventory of fish, algae, macro and micro invertebrates, birds, mammals, reptiles and amphibians, and macropytes available in the draft book chapters. This information covers main lake and satellite lakes. Mapping of these areas is in progress	Inventories have been compiled from main lake and satellite lakes. Rocky habitats not sampled due to lack of appropriate gears Fish, macro/micro-invertebrates and macrophytes covered.	Inventory has been compiled on fish, algae, macro and micro invertebrates, macrophytes. Surveys have been made in non-trawlable areas (rocky, vegetated and sandy habitats) and in satellite lakes
c) Carry out taxonomic studies of endangered species, prepare and publish guides on taxonomy of these species	Taxonomic studies done in various biota and information in draft books Problems – Taxonomy of algae, and haplochromines	Had constraint on Haplochromine taxonomy. Taxonomic studies of other biota done. Invertebrates identified only to broad taxonomic levels due to problems of equipment and taxonomic identification,	Information available on algae, zooplankton, macro-invertebrates and fish except for the haplochromine and Barbus. However, a taxonomic guide is still required

		keys Consultancy needed in this area.	
d) Set up museum collection to be used for education, research and other purposes	Museum rehabilitated and stocked; established herbarium and aquarium facilities for education have been set up. There is need for technical assistance to upgrade set up of aquarium and museum.	Specimens of fish and macro-invertebrates collected. There is a problem of storage space. Technical assistance needed on curation techniques. National Museum of Kenya could help to store specimens	Specimen collected and kept in the laboratory. Setting up the aquarium and museum facilities is in the final work-plan
e) Propagate and conserve those species that are threatened	Propagation of endangered species in aquarium is done by Aquaculture sub-component and preliminary results are available. Aquaria stocks also form part of this activity	Threatened fish species collected. To liaise with aquaculture sub-component for propagation of these species. Species maintained in aquaria.	Aquaculture sub-component is undertaking this activity by propagating fingerlings to fish farmers
f) Carry out lake-based aquaculture for restoration of endemic species	This activity is to be handled by Aquaculture sub-component	To be handled by aquaculture sub-component	*O. variabilis* experiments have been conducted for both MSc and PhD Aquaculture students
g) Study behavior and life history strategies of surviving species	Handled by a student and preliminary results available i.e. surviving species of Haplochromines, tilapines and other fishes	Studies have been initiated for Haplochromines and other Cichlid species	This study has not been undertaken
h) To undertake trophic studies in fish and to determine productivity in Lake Victoria and provide suitable models of their	Handled by a Ph.D. student and preliminary results available in one of the book drafts	Trophic studies underway for Nile perch and Haplochromines only. Handled by one MSc. and one Ph.D. students	Trophic studies have been conducted for *O. variabilis*. Similar studies have also been made on satellite lakes

relationships			
i) Determine tolerance of surviving species to environmental conditions especially oxygen	Handled by one Ph.D. student and is in progress. Results are expected	Not yet done due to lack of facilities. Laboratory experiments have been recommended. There is need for the three institutes (FIRRI, KEMFRI and TAFIRI) to work together on this activity. A university student could be taken on to implement this activity	This study has not been effected
j) Examine the genetic state of the major surviving species and of introduced species	Collaborator Dr. Mwanja is undertaking this activity on Nile perch, native *esculentus*, *O. niloticus*, selected Haplochromines and *Labeo* victorianus, preliminary results are available	Nile perch and Tilapiines are being handled. One student project is on going. Other fish species not yet done.	A PhD student is examining the genetics of some surviving cichlids in the lakes
k) Set up marine parks	Some information is available for Fisheries Department to undertake this task - Sites have been selected (satellite lakes, shoreline areas, river mouths and rocky areas) for biodiversity conservation	To be undertaken by Fisheries Department based on information and guidelines generated by the sub-component	The task is under the mandate of the Fisheries Department, based on the information generated by the sub-component
l) Draw up a conservation education program on conservation / extinction of species and how this	Information has been generated and recommendations formulated	To be done together with Information dissemination after the necessary information has been	Collaboration with Fisheries Department to conserve satellite lakes has started. This involves also the socio-

m) To undertake survey, collection, retrieval and storage of literature on Lake Victoria ecosystem and its ichthyofauna	Information and database sub-component is undertaking this task. Information sourced locally and internationally	Literature has been sourced Locally and compiled by Database sub-component	The Information and database Sub-component is working on this and initial output is in place. The Aquaculture sub-component has also collected reprints from journals and bound them into 44 volumes. The library has subscribed to several new journals and new books have been bought. Internet search is facilitated through the *Reference Manager* software.
n) Develop training and research capabilities at riparian research institutes and universities to provide expertise to study native biodiversity their conservation and management	5 Ph.D. students are undergoing training locally and abroad. Several technicians trained on short-course training courses locally and abroad - Information and Database sub-component has set up training facilities - 3 MSc have been completed – theses published	1PhD student, and 2 MSc students being trained though more staff require training. Equipment not yet procured.	2 PhD and 4 MSc students are on training abroad and locally and they will finish their studies shortly. Most of the equipment has been procured. RV Tafiri ii has been rehabilitated and is now operational.

3.6 WORLD BANK RECOMMENDATIONS AS PER AIDE MEMOIRE (2000/2001):

(i) Uganda

- Avail adequate staff time for completion of the books
- Reduce sampling efforts for in-Lake surveys.
- Improve internet and email line connection and time to enhance literature search
- Component to invest more on publications
- Increase attention on satellite lakes
- Increase attention on improvement of physico-chemical variables
- Establish strategic plans for the conservation and management of native fish and fauna.
- Prepare management work plan for satellite lakes and non-trawlable areas in Lake Victoria.
- In collaboration with the socio-economics sub-component, conduct Socio-economic analysis on satellite lakes for community conservation efforts
- Initiate collaboration with local institutions
- In collaboration with Fisheries management, explore involvement of community in beach management
- Analysis for wetland biodiversity documentation.
- Wetlands sub-component to collaborate with Zoology and Fisheries Management sub-components on development of management plans for wetlands
- Shoreline communities involvement in management collaborators
- Field research activities be done according to work plans and timely accountability of the activities in order to allay flow of funds to student projects

(ii) Kenya.

- A primary goal of the coming year's work plan must be to accomplish these surveys at regular intervals. To insure this, the subcomponent and component leader must define a critical core work plan that insures evenly distributed sampling surveys through the year. It is recommended that this be bimonthly for the in-lake surveys and that satellite lakes be visited on a quarterly basis.
- It is recommended that river sampling be added to the sampling program as preliminary research has found some fishes formerly found primarily in the Lake are still occurring in the river.
- It is recommended that the mouths and lower reaches of the rivers be surveyed during in-lake cruise while the upper reaches can be sampled at road access points during surveys on the satellite lakes.
- Regular sampling intervals must be maintained.
- Lake surveys should be done on a regular sample schedule as emphasized above, but special effort must go into the non-trawl able areas because most prior sampling as been based on trawling, rocky shores, grounds, weedy areas and shallow areas.
- The subcomponent should initiate discussions with Fisheries Management to explore appropriate management actions, which might be implemented to ensure the sustainability of these faunal remnants.
- The subcomponent should already begin to prepare and circulate reports and publications on the results of their surveys, which have confirmed the presence of the relict fauna in the satellite lakes.
- A common GIS format to facilitate conservation management planning and data sharing among the countries should be agreed and funded.

(iii) Tanzania

- Divert much attention to book writing
- More information to be generated on satellite lakes and non-trawlable areas
- Scaling down sampling efforts in the main lake
- Literature searching and access to publication be enhanced for facilitation of publishing
- Adoption of strategy for the conservation of native fauna in localities where they are found
- Institution of conservation management units on the satellite lakes
- Initiate a process to set up conservation educational facilities at TAFIRI Mwanza

3.7 REGIONAL SAMPLING OF SATELLITE LAKES

During the last Regional meeting, it was recommended that there should be a regional sampling for satellite lakes. This has not taken place due to different problem from the 3 countries. Due to the uniqueness of biota in these satellite lakes and the need for conservation of the biodiversity, there is need to proceed with this exercise at the earliest possible opportunity. It was therefore agreed that the process to set up modalities for sampling satellite lakes be re-initiated and a work plan for the execution of this exercise be developed and agreed upon.

- The Chairman observed that there are difficulties in sampling satellite lakes in terms of logistics and costs due to the number of staff involved.
- Dr Wakwabi pointed out the need to re-assess the financial situation and re-schedule the sampling program emphasizing the most critical sites/areas.
- Dr. Ndawula suggested that days be set-aside in every quarter for sampling satellite lakes in the three countries. There was fear that this program might be hampered by lack of funds in any hosting country.

WAY FORWARD

- It was proposed and agreed that each country set up a team of 4 scientists to sample satellite lakes regionally that all national scientist to participate during sampling in their own country.
- Each country budget for the team members participating in the regional lake sampling activities
- The tentative sampling schedule shall be during the 2nd half of September 2001:
- Sampling will be done at -**L.Kanyaboli** (Kenya) – **L.Nabugabo** (Uganda) and **L. Ikimba** (Tanzania)
- Sampling order shall be L.Kanyaboli, in **Kenya,** L.Nabugabo in **Uganda** and with L.Ikimba in **Tanzania**
- Three days (3) of sampling and two (2) days of cross border travelling totaling 15 days should be set aside for this activity.
- All scientists involved in the sub-component will do sample and data analysis for three days. This exercise will be done in Jinja, Uganda. Immediately following the sampling activity. .It was envisaged that the exercise will culminate in a regional workshop to harmonize the methods and results from this study
- A consultancy on training can be organized to take place during this time.
- The regional sub-component leader should coordinate this activity and raise up the matter with LVEMP secretariat as soon as possible.

3.8 TRANS-BOARDER SAMPLING: (BORDER PILOT ZONES)

The Trans-border sampling zones were chosen based on their uniqueness in characteristics for biodiversity and ease of approach for both countries. The zones to be samplied include **Sio** on Kenya and Uganda border, **Kagera** on Uganda and Tanzania borders and **Mara** on the Kenya and Tanzania border. The Chairman noted that Trans-border sampling had not been done jointly though each country has been sampling their side of the rivers.

The following options were suggested for action, that either

a) The countries involved get together and plan joint sampling activities

Or

b) The countries involved draw a program where each country sample areas within their borders and share the results across the borders for comparison purpose. Should this be the case, then the sampling on either side should be planned to fall around the same time for ease of comparison.

WAY FORWARD

It was proposed and agreed that:

- Sio pilot zone – Kenya and Uganda sample areas within their borders and inform each other when sampling is taking place for possible synchronization with the sampling in the sections of the river on either side.
- Kagera pilot zone -Uganda and Tanzania sample areas within their borders and inform each other when sampling is taking place for possible synchronization with the sampling on the sections of the river on either side. In addition to this since Tanzania has only one sampling trip to make, Tanzania should take the initiative to will inform Uganda when they will be sampling this zone for Uganda to join in the sampling activities
- Mara pilot zone -Kenya and Tanzania: For the same reasons as on the Kagera, Tanzania will inform Kenya when Kenya will be sampling this area so that they can join them during the activity. Sampling methodologies will be standardized
- Set up a strategic sampling program covering both dry and wet seasons to allow comparability of data.

3.9 REGIONAL CONSULTANCY

This undertaking was agreed upon during the meeting in Tarime Tanzania (1999). The areas for consultancy were agreed upon. It was then proposed that the consultancy be regional in scope. TOR's were prepared and budgets put in place. Later, the World Bank declined to endorse this activity. However, work has been

going on even in those areas originally deemed to require consultancy inputs. In some cases Collaborators have been used to cover these areas. There was therefore a need to re-assess and identify common areas needing consultancies were still where for the three countries.

The areas were identified and ranked for each country as follows:

CONSULTANCY AREAS	PRIORITY RANKING		
	KENYA	UGANDA	TANZANIA
Fish Genetics	5	7	7
Macro-invertebrate taxonomy	**2**	3	8
Taxonomy of Haplochromines	**1**	1	1
Museum and aquaria	4	6	**2**
Synthesis of the two books	3	**5**	6
GIS information on Biodiversity	6	4	**3**
Reptiles and amphibians	7	-	5
Algal Taxonomy	-	**2**	4

WAY FORWARD

- Areas for consultancy requirement common to the three countries were identified for priority action. Only ranked with priority 1-3 were considered.
- The country having the highest priority ranking will take up the consultancy and invite the other 2 countries to participate in activities.
- Consultancies for these areas were awarded to each country as follows

Kenya

Macro-invertebrates taxonomy

Taxonomy of harplochromines

Uganda

Algae taxonomy

Synthesis of the two books

WAY FORWARD

- Need was expressed to find suitable training institutions to undertake GIS training for the sub-component personnel
- The sub-component leader to coordinate this activities and inform the secretariats on the time frame when this activity should begin
- The original terms of references (TOR's) for each consultancy area remain the same. The responsible country should just abstract them from the document for effecting.
- Each country to communicate to the other two on the procedures for procurement of consultancies it is undertaking
- This activity should be given priority to start immediately.

3.10 PREPARATION OF THE TWO BOOKS

The Chairman informed the meeting that the decision to prepare the two books was originally taken up during the Tarime (Tanzania) meeting of the sub-component. The World Bank suggested a consultant to help in writing the books. The role of this consultant was to review the manuscripts from scientists. Scientists working in similar areas were to co-author publishable papers. The manuscripts could then be synthesized into book chapters. Uganda had already put in place drafts of the book chapters that are under review as fresh information flows in

There is need to prepare modalities and procedure in the preparation and time frame for production of these books. Each country was asked to give a brief on the status of this activity from their sub-component.

3.11 COUNTRY BRIEFS.

(i) KENYA:

The Deputy Director, KMFRI said he is impressed with Uganda's initiative who have already produced the draft's of the two books. This would serve as a starting point for this regional undertaking. Due to some unavoidable circumstances, it has not been possible for the Kenyan counterparts to put together their information into similar drafts. He pointed out that the proposed books are not for LVEMP *per se*, but sources of information for the region and indeed beyond the region on what we know about Lake Victoria. The drafts should therefore include, avail all information from as far back as possible on the Lake. He pledged to encourage Scientists from KMFRI to put together whatever information they have so far achieved and produce papers towards the production of these two books.

(ii)TANZANIA

The Tanzanian scientists are yet to prepare and submit their contributions to the book chapters. The task coordinator promised to mobilize and facilitate the concerned scientists and ensure that their in-puts are ready as soon as possible.

(iii) UGANDA

The scientists in Uganda have already prepared draft chapters of the two books on Fish Biology and Ecology, and Biodiversity aspects. The drafts are under constant review as new data is collected.

WAY FORWARD

- It was decided to schedule a regional technical workshop where results of the first four years of LVEMP research work would be presented.

- A 3 days Workshop was therefore proposed to be held in January 2002 at Mwanza, Tanzania.
- The deadline to submit abstracts for this workshop shall be end of September 2001.
- It was emphasized that while looking for a consultant to synthesize the two books, a local consultant should be preferred.
- Tanzania and Kenya were given up to end of June 2001 to inspect agreed chapter titles and forward their comments to the Regional sub-component leader.
- The regional sub-component leader to liaise with sub-component coordinators in Tanzania and Uganda to draw up a timetable for the workshop.
- Papers presented during this workshop will form the bulk of these book chapters

3.12 CLOSING REMARKS

The Deputy Director, KMFRI commented that the workshop had been a useful exercise for the exchange of views. It facilitated the sub-component to reach amicable decisions on the way forward. He emphasized that it is our duty to accomplish what was agreed. He appreciated the participants for their open and frank deliberations during the workshop.

The Director, FIRRI thanked participants for their useful contributions to the deliberations. Thanked Dr. Wakwabi for catching up with the activities of the project, as he is still new in the sub-component affairs

4.0 ANNEXES

Annex 1

LIST OF PARTICIPANTS.

NAME & ADDRESS

UGANDA

1 Namulemo Gertrude
Fisheries Resources Research Institute (FIRRI)
P.O. Box 343, Jinja
Tel: 256-043-120484
Email: firi@infocom.co.ug

2 Stephen Sekiranda
Research Officer
Fisheries Resources Research Institute (FIRRI)
P.O. Box 343, Jinja
Tel: 043-120484
Email: firi@infocom.co.ug

3 Lucas Ndawula (Dr)
Research Officer
Fisheries Resources Research Institute (FIRRI)
P.O. Box 343, Jinja
Tel: 043-120484
Email: firi@infocom.co.ug

4 Dr. Ogutu-Ohwayo, Richard
Director,
Fisheries Resources Research Institute (FIRRI)
P.O. Box 343, Jinja
Tel: 256-043-121369
Email: firi@infocom.co.ug

5 Wandera Sylvester Bwaku
Research Officer
Fisheries Resources Research Institute (FIRRI)
P.O. Box 343, Jinja
Tel: 256-043-120484
Email: firi@infocom.co.ug

6 Mbabazi Dismas
Research Officer
Fisheries Resources Research Institute (FIRRI)
P.O. Box 343, Jinja
Tel: 256-043-120484
Email: firi@infocom.co.ug

7 Dr. J. S. Balirwa
Senior Research Officer
Fisheries Resources Research Institute (FIRRI)
P.O. Box 343, Jinja
Tel: 256-043-120484
Email: firi@infocom.co.ug

KENYA

8 Dr. Enock O. Wakwabi
Deputy Director/Component Co-ordinator
Fisheries Research, KMFRI
P.O. Box 1881, Kisumu
TelFax 254-35-21461, Mobile 0733-837974
Email: : kmfkisu@net2000ke.com

9 Mutune D. Masai
Task Co-ordinator, Fish Biology and Biodiversity Conservation
Fisheries Research Component
Kenya Marine & Fisheries Research Institute
P.O. Box 1881
Tel: 23604, 21461
Fax: 21461, 23604
Email: kmfkisu@net2000ke.com

TANZANIA

10 Mr. Egid F. Katunzi
Centre Director/ Task Leader
Fisheries Biology and Biodiversity Conservation Subcomponent
Tanzania Fisheries Research Institute, TAFIRI
P.O. Box 475, Mwanza
Tanzania
Tel: 255 28 2552398
Email: katunzi@hotmail.com

11 Mr Shigalla B. Mahongo
Co-ordinator, Fisheries Research Component
Tanzania Fisheries Research Institute, TAFIRI
P.O. Box 9750, Dar es Salaam
Tanzania
Tel: 255 22 2650045 - Fax: 255 22 2650043
Email: mahongo@hotmail.com

FISH BIOLOGY AND BIODIVERSITY SUB-COMPONENT REGIONAL WORKSHOP PROGRAMME – 28 MAY 2001

	ACTIVITY	RESPONSIBLE PERSON
	Registration of participants (Annex 1)	Kakuru
	Workshop Programme (Annex 2)	
	Welcome remarks	Director, FIRRI
	Introduction of workshop	Regional sub-component Leader- Director, KEMFRI
	An overview of the original objectives of the Fish Biology and Biodiversity sub-component (Annex 3)	Dr. Ogutu-Ohwayo
	National Progress Briefs including highlights of the recent World Bank Review Mission (Annex 4). Kenya (4a), Tanzania (4b), Uganda (4ci & 4cii)	
	Coffee/Tea break	
	Regional sampling of satellite lakes (Annex 5)	Katunzi
	Discussion and way forward	
	Trans-boundary sampling (Annex 6)	Sub-component Leader, Kenya
	Discussion and way forward	
	Lunch break	
	Discussion of consultancy requirements: Original Terms of Reference (Kenya, Tanzania, Uganda) (Annex 7)	
	Terms of reference and time frame for consultancy on Fish Biology and Biodiversity conservation sub-component (Annex 8)	
	Discussion and way forward	
	Preparation of books: Agreed chapters for the books (Annex 9)	Dr. L. Ndawula
	Discussion and way forward	
	Tea/coffee break	
	Rapporteurs prepare report	Rapporteurs
	Presentation of workshop report	Representative of Rarppoteurs
	Closing remarks	Director KEMFRI Director TAFIRI Director FIRRI

Annex 3

The Original Objectives: Fish Biology and Biodiversity Conservation Sub-component; LVEMP.

Main Objective

The goal of this Sub-Program is to generate a knowledge base that will be used to curtail further losses in species, conserve and improve aquatic biodiversity and genetic resources so that Lake Victoria can gain values lost by declining biodiversity and genetic resources and maximize ecosystem utilization by these species. It will also train manpower and provide facilities necessary for operation of the project.

Specific Objectives

- Identify the main factors affecting aquatic biodiversity and recommend means of managing them
- Make an inventory of existing and threatened aquatic biodiversity and map out habitats where these species are surviving (satellite lakes, rocky / macrophyte refugia etc.)
- Carry out taxonomic studies of endangered species, prepare and publish guides on taxonomy of these species.
- Set up museum collection to be used for education, research and other purposes.
- Propagate and conserve those species that are threatened.
- Carry out lake based Aquaculture for restoration of endemic species and to reduce pressure on the wild stocks.
- Study behavior and life history strategies of surviving species.

- To undertake trophic studies in fish and to determine productivity in Lake Victoria and provide suitable models of their intricate trophic relationships.
- Determine tolerance of surviving species to environmental conditions especially oxygen.
- Examine the genetic state of the major surviving species and of introduced species
- Set up marine parks
- Draw up a conservation education program on conservation / extinction of species and how this affects humanity.
- To undertake survey, collection, retrieval and storage of literature on Lake Victoria ecosystem and its ichthyofauna
- Develop training and research capabilities at riparian research institutes and universities to provide expertise to study native biodiversity their conservation and management

Highlights from the recent World Bank Aide Memoire

(i) - Uganda

- Up to four years of data are available for the main lake and satellite lakes receive attention as well. Therefore,
- Adequate staff time will be availed to complete the biodiversity books,
- Reduction in sampling effort from the main lake program but not the satellite lakes and non-trawlable areas of the lake;
- Increases in e-mail and Internet time to facilitate literature searches, access to electronic journals over the wet and communicating with co-authors and international experts will be made.
- The sub-component will invest more funds to support the preparation of publications and reflect this in annual and quarterly workplans of the sub-component. In the addition, the sub-component will take up the following:
- Pay increased attention to the importance of satellite lakes, non-trawlable areas and non-seinable areas of Lake Victoria and important refugia for the native Victoria fauna.
- Increased attention will be given to determine the physical, chemical and biological aspects of the systems, and detailed surveys will be carried out in the coming year.
- A strategic plan for the conservation of the native fauna in those localities and present it to Fisheries Management by September 2001.
- Management plan to be developed for each Satellite Lake and important non-trawlable areas in Lake Victoria.

- Carry out socio-economic analysis of the satellite lake communities

- Work closely with national institutes, riparian universities and international collaborators and other long-term research collaborators to insure that the TOR's for the withdrawn consultancy are fulfilled.

- Fisheries Management with advice and involvement of the sub-component will explore options including development of Community-based Conservation or Beach Management Units with the current stakeholders who are dependent on the satellite lakes for their livelihood.
- GIS analysis by the wetlands component will be linked to the sub-component in documenting the aquatic biodiversity in fringing wetlands on the lake. Biotic overlays will also be part of the GIS database on wetlands,
- In cooperation, the sub-component, Wetlands Management, Zoology Department and Fisheries Management will work in close partnership to produce the requisite management plan for the Nabugabo satellite lake area to be gazetted as a Ramsar site,
- A thorough social and economic study will be made of the Nabugabo area
- Water quality assessments of shoreline communities will be initiated and
- Undertaken with collaborative planning with MUIENR, NWSC, FIRRI, Public health and community members in relation to the FIRRI completed socio-economic analysis of several fishing communities including a health assessment for water-borne diseases,
- Field research activities, which are essential, will be undertaken and careful attention to work plans and accountability statements will be made so that field activities take place as planned. The Graduate Programs involve: S.B. Wandera, J.P. Olowo, G. Namulemo, D. Mbabazi, S. Ssekiranda, and the following requirements will be met:
- *Plan carefully and provide the Secretariat with sufficient information on the Work planning process and timely accounting to insure that student programs are not unduly affected*

- **(ii) KENYA**

- A primary goal of the coming year's work plan must be to accomplish these surveys at regular intervals. To ensure this, the subcomponent and component leader must define a critical core work plan that insures evenly distributed sampling surveys through the year. It is recommended that this be

bimonthly for the in-lake surveys and that satellite lakes be visited on a quarterly basis.

- It is recommended that river sampling be added to the sampling program as preliminary research has found some fishes formerly found primarily in the Lake are still occurring in the river.
- It is recommended that the mouths and lower reaches of the rivers be surveyed during in-lake cruise while the upper reaches can be sampled at road access points during surveys on the satellite lakes.
- Regular sampling intervals must be maintained.
- Lake surveys should be done on a regular sample schedule as emphasized above, but special effort must go into the non-trawl able areas because most prior sampling as been based on trawling, rocky shores, grounds, weedy areas and shallow areas.
- The subcomponent should initiate discussions with Fisheries Management to explore appropriate management actions, which might be implemented to ensure the sustainability of these faunal remnants.
- The subcomponent should already begin to prepare and circulate reports and publications on the results of their surveys, which have confirmed the presence of the relict fauna in the satellite lakes.
- A common GIS format to facilitate conservation management planning and data sharing among the countries should be agreed and funded.

(iii) TANZANIA

- Divert much attention to book writing
- More information to be generated on satellite lakes and non-trawlable areas
- Scaling down sampling efforts in the main lake
- Literature searching and access to publication be enhanced for facilitation of publishing
- Adoption of strategy for the conservation of native fauna in localities where they are found
- Institution of conservation management units on the satellite lakes
- Initiate a process to set up conservation educational facilities at TAFIRI Mwanza

Original terms of reference for the joint regional International Consultancy on Fish Biology and Biodiversity Conservation of Lake Victoria for the Lake Victoria Environmental Management Project (Kenya, Tanzania and Uganda)

5.1 Background

Lake Victoria is the second largest freshwater lake in the world and has the largest freshwater fishery in the world. The fishery is based on an introduced predatory fish, Nile perch which supports an important export fishery for the three riparian countries. The lake formally had a famously diverse ichthyofauna comprised of hundreds of endemic fishes almost all of which were haplochromine cichlids. Much of this exceptional biodiversity is thought to have been lost or severely reduced since the introduction of the Nile perch. The magnitude of the loss/reduction is still to be determined because comprehensive biotic surveys have not been done. Because the haplochromine species flock was trophically diverse and specialised, the other biota of the lake were affected by the altered trophic structure of the lake. The other biotic elements were less known than the fishes which had attracted scientific attention because of their evolutionary significance.

The lake has also experienced a serious decline in water quality since the 1960's. Phosphorus concentrations have risen by a factor of two, algal biomass have increased by a factor of 8 to 10, the deep waters of the lake are more depleted in oxygen for longer periods of time each year, and filamentous and colonial blue-green algae now dominate the algal community. Most recently water hyacinth has invaded the lake. These changes are evidence for a profound eutrophication of this great lake, which may still be accelerating causing concern for many domestic, agricultural, and industrial uses of the lake. These water quality changes would also be expected to alter the food webs in the lake and cause community changes in higher organisms. There is also evidence that these water quality changes have favored the success of the Nile perch and contributed to the extirpation and extinction of hundreds of endemic fish species and other organisms.

The fishing pressures on the stocks of the lake have escalated dramatically with the success of the Nile perch, which has produced a high-value export product. The intense harvest has raised concerns about the sustainability of the fishery. The extreme fishing pressure may contribute to the demise of many fish species or affect their re-establishment unless it is correctly managed. While ecosystem changes are documented, the causes for these changes are uncertain because basic data have not been acquired over time on the abundance and diversity of the lake's biota. Also the fundamental life history and genetic diversity of the native and introduced fishes are inadequately known to guide management actions which will attempt to maintain the lake's productivity while defining strategies for restoring desirable species and communities and maintaining biodiversity.

The three riparian countries around Lake Victoria, Kenya, Uganda and Tanzania, with funding from the Global Environmental Facility (GEF) and the International Development Agency (IDA) are responding to these issues and other fisheries, land use and socio-economic issues of concern on Lake Victoria through the Lake Victoria Environmental Management Project (LVEMP). LVEMP is a comprehensive program conducted by the three countries aimed at rehabilitation of the lake ecosystem for the benefit of the 20 million people who live in the catchment, their national economies and the global community. One of the critical components of LVEMP concerns Fish Biology and Biodiversity Conservation. The three countries implementing LVEMP have recognized that Lake Victoria is a single ecosystem and that actions by any riparian country can affect the biota of the entire lake. There is also recognition that effective management action to achieve LVEMP's objectives requires the best possible information on the biota of the lake and understanding of probable interrelationships among the biotic elements, especially fishes, and the factors which determine biodiversity.

According to the Convention on Biological Diversity (CBD), Biological diversity refers to: *"the variety and variability of all animals, plants and micro-organisms and ecological complexes of which they are part; this includes ecosystems diversity, species diversity and genetic diversity"*. There is need to define and understand biodiversity of Lake Victoria from the ecosystem, through the community, down to species and genetic level, and this will require application of and training in a broad range of sciences and techniques.

To achieve this, a consultancy is required, to be funded by the three countries to: advise on upgrading of facilities (laboratories, museums, aquarium); recommend appropriate training in required skills; assist in planning biodiversity surveys; carry out on-job training in ecosystem, taxonomic and genetic studies; advise and participate in preparation of database and information dissemination materials (books, booklets, brochures, posters, video films etc); advise on in-situ and ex-situ conservation efforts (museums, aquarium, marine parks etc); and advise on community participation in conservation and sustainable use efforts.

5.2. Objective

The Fish Biology and biodiversity Conservation program will, with the assistance of this consultancy,

"rectify the serious lack of knowledge about the biota of the lake, focusing especially on non-commercial fish of biological and ecological importance, their species composition, population structure, genetic diversity, food and feeding habits, trophic relationships, reproduction and breeding habits, recruitment patterns, growth, mortality, migrations, habitat and environmental requirements. It also examine other organisms which play key roles in sustaining the Lake Victoria ecosystem, including other aquatic vertebrates (frogs, reptiles, birds and mammals), microinvertebrates (copepods, cladocerans and rotifers), macroinvetrebrates (insects, mollusks, crustaceans), algae (diatoms, cynophytes, green algae), macrophytes and bacteria."

The primary aim of this program is to gain information with which to design initiatives to sustain a complex ecosystem of substantial economics and scientific importance. The outcomes of the studies will be species distribution and habitat maps, information on genetic diversity of different populations, understanding of the causes of decline of fish species, understanding of the impact of environmental changes on the biology, behavior and survival of the declining species, guidelines for species conservation and restoration, an updated bibliography of Lake Victoria, training of scientists, and dissemination of information to stakeholders.

The riparian countries have emphasized that the consultancy will advise and assist on the provision of information to guide sustainable development of the lake's biological resources and ecosystem management. This will include the following specific activities:

2.1. To obtain and provide information on the biology and ecology of fishes, (food and feeding habits, trophic relationships, reproduction and breeding habits, recruitment patterns, growth, mortality, migrations and habitat requirements) especially of non-commercial fish of biological and ecological importance to Lake Victoria and those water bodies with intimate connection to the lake to guide restoration, management and sustainable use of these fishes.

2.2. To conduct on-job training including field survey methods and analyses on the following aquatic taxa:
a) haplochromines and other native fish species;
b) macrophytes;
c) algae;
d) micro-invertebrates;
e) macro-invertebrates; and
f) other lower and higher vertebrates.

2.3. Assess and develop facilities in DNA techniques in riparian countries and conduct studies on genetics of haplochromines, tilapiines and other endangered but previously economically and ecologically important fish species using appropriate DNA techniques;

In carrying out this assignment, the consultants for the different specialized areas will: assess the needs of the riparian research institutions and develop a plan to strengthen the capacity of these institutions including a training program; design and develop standard protocols in surveys aimed at obtaining an inventory of aquatic biodiversity of the specific taxa in Lake Victoria and those water bodies with intimate connections to the lake and having endangered Lake Victoria fauna and flora; participate in preparing illustrated keys and taxonomic guides of the different taxa.

2.4. To advise on the establishment of *in-situ* and *ex-situ* conservation facilities (museums, aquarium, marine parks) at the national lakeside laboratories and locations of the riparian countries in order to support modern curation and public education; and develop protocols for conservation and restoration of native fish species through various methods;

2.5 To advise and participate in compilation of information including production of at least two books one on: "***The Biology and Ecology of Lake Victoria Fishes: Their Development and Management***" and the other on "***Biodiversity of Lake Victoria: Its Conservation and Sustainable Use***" as well as other educational materials (booklets, brochures, posters, videos and mass media materials) and assist in creation of a geo-referenced database on the diversity of fishes, other fauna, and flora of Lake Victoria and the factors affecting their survival.

2.6. To develop protocols for community participation in conservation and sustainable use of the Lake Victoria aquatic biodiversity.

3. Special aspects

Lake Victoria has a surface area of approximately 69,000 km^2 and a catchment area of 195,000 km^2, which contains extensive wetlands, and small water bodies, which have (or have had) a hydrological connection with Lake Victoria in the past and therefore are potential refugia for Victorian biotic and genetic diversity. The aquatic biological diversity of this tropical great lake and tributaries is known to be exceptional both in numbers of species and their endemism. It is necessary to address the requirements of this consultancy on biogeographic and biosystematics scales while addressing the taxonomic fine scale of highly endemic faunas with specific habitat requirements. There is need to co-ordinate and collaborate with institutions and communities, but especially the Kisumu Laboratory of the Kenya Marine and Fisheries Research Institute (KMFRI), the Mwanza Laboratory of the Tanzania Fisheries Research Institute (TAFIRI) and the Jinja Laboratory of the Fisheries Research Institute (FIRI) of Uganda. This consultancy will require a number of personnel in specialized areas. These will include:

a) Fish Biology and Ecology
b) Taxonomy and ecology of aquatic macrophytes
c) Algal taxonomy and ecology
d) Micro-invertebrate taxonomy and ecology
e) Macroinvertebrate taxonomy and ecology
f) Fish taxonomy and ecology with specific emphasis on haplochromines
g) Other vertebrates (amphibians, reptiles, birds and mammals)
h) Fish genetics
i) Biodiversity Conservation
j) Museum / Aquarium / Marine park
k) Community Participation
l) Impact studies

5.3 Titles, qualifications, experience and duties of personnel to carry out the study.

The required qualification of the different experts is given below.

3.1. The Aquatic Macrophytes Specialist

Qualifications

A degree in biology with postgraduate experience in aquatic macrophytes. At least 10 years experience of work on aquatic macrophytes preferably in East Africa.

Duties

The aquatic macrophyte specialist will design and develop protocols in surveys aimed at obtaining an inventory of the diversity and distribution of aquatic macrophytes in Lake Victoria and those water bodies with intimate connection to the lake. He will carry out on-job training and participation in collection, analysis, and preservation of aquatic macrophytes; preparation of keys and taxonomic guides of aquatic macrophytes; advise and participate in compilation of information on aquatic macrophytes together with regional counterpart scientists into a chapter to be included in the book on Biodiversity of Lake Victoria.

3.2. The Specialist in Aquatic Algae

Qualifications

A degree in biology with Post graduate experience at MSc or PhD level in aquatic algae. At least 10 years experience of work on aquatic algae preferably on East African Great Lakes.

Duties

The aquatic algae specialist will design and develop protocols in surveys aimed at obtaining an inventory of the diversity and distribution of aquatic algae in Lake Victoria and those water bodies with intimate connection to the lake. He will carry out on-job training of research scientists and technicians including survey methods and participate in collection, analysis, and preservation of aquatic algae; preparation of keys and taxonomic guides of aquatic algae; advise and participate in compilation of information on aquatic algae together with regional counterpart scientists into a chapter to be included in the book on Biodiversity of Lake Victoria.

3.3. The Specialist in Aquatic Invertebrates

Qualifications

A degree in biology with Postgraduate experience at MSc or PhD level in aquatic invertebrates. At least 10 years experience of work on aquatic invertebrates preferably in East Africa.

Duties

The aquatic invertebrates specialist will design and develop protocols in surveys aimed at obtaining an inventory of the diversity and distribution of aquatic

invertebrates in Lake Victoria and those water bodies with intimate connection to the lake. He will carry out on-job training of research scientists and technicians including survey methods and participation in collection, analysis, and preservation of aquatic invertebrates: preparation of keys and taxonomic guides of aquatic invertebrates; advise and participate in compilation of information on aquatic invertebrates together with regional counterpart scientists into a chapter to be included in the book on Biodiversity of Lake Victoria.

3.4. The Fish Taxonomy Specialist

Qualifications

A degree in biology with Post graduate experience at MSc or PhD level in fish taxonomy with specific reference to haplochromines. At least 10 years experience of work in fish taxonomy preferably of haplochromines in East Africa.

Duties

The fish taxonomy specialist will design and develop protocols in surveys aimed at obtaining an inventory of the diversity and distribution of fish especially of haplochromines in Lake Victoria and those water bodies with intimate connection to the lake. He will carry out on-job training of research scientists and technicians including survey methods and participation in collection, analysis, and preservation of fish, preparation of keys and taxonomic guides of fish; advise and participate in compilation of information on fish taxonomy together with regional counterpart scientists into a chapter to be included in the book on Biodiversity of Lake Victoria.

3.5. Other vertebrates (amphibians, reptiles, birds and mammals)

Qualifications

A degree in biology with Postgraduate experience at MSc or PhD level in studies of amphibians, reptiles, aquatic birds or aquatic mammals. At least 5 years experience of work in with amphibians, reptiles, or aquatic birds aquatic mammals.

Duties

The specialist handling amphibians, reptiles, aquatic birds and aquatic mammals will design and develop protocols and carry out surveys to obtain the diversity and distribution of amphibians, reptiles, aquatic birds and mammals of Lake Victoria and those water bodies with intimate connection to Lake Victoria including the shoreline of these water bodies. He will compile the information into a chapter to be included in the book on Biodiversity of Lake Victoria.

3.6. The Fish Biologist

Qualifications

A degree in biology with at least a PhD in fish biology. He/she should have at least 10 years experience of work on tropical fishes. Experience of research supported by extensive publications in international journals especially on the fishes of Lake Victoria will be an added advantage.

Duties

The fish biologist will design and develop protocols in surveys aimed at obtaining information on the biology and ecology of fishes, (food and feeding habits, trophic relationships, reproduction and breeding habits, recruitment patterns, growth, mortality, migrations and habitat requirements) especially of non-commercial fish of biological and ecological importance to Lake Victoria and those water bodies with intimate connection to the lake. He will carry out on-job training of research scientists and technicians including survey methods and participate in collection, analysis, and documentation of these aspects; advise and participate in compilation of information on the biology and ecology of these fishes; advise the relevant regional counterpart scientists in preparation of the various chapters to be included into a book on the Biology and Ecology of Lake Victoria fishes.

3.7. Fish Geneticist

Qualifications

A degree in biology with Post graduate experience at MSc or PhD level involving DNA techniques in fish. At least 5 years experience of work in fish genetics using DNA techniques preferably on East Africa fishes especially haplochromines.

Duties

Assess and develop facilities in DNA techniques in riparian countries and conduct studies on genetics of haplochromines, tilapiines and other endangered but previously economically and ecologically important fish species using appropriate DNA techniques;

In carrying out the above assignment, the consultants for the different specialised areas will also assess the needs of the riparian research institutions and develop a plan to strengthen the capacity of these institutions including a training program and design.

3.8. The Aquatic Biodiversity Conservation Specialist

Qualifications

A degree in biology with Postgraduate experience related to aquatic biodiversity conservation. Experience of similar work in East Africa will be an added advantage.

Duties

To advise on the establishment of in-situ conservation facilities (museums, aquarium, marine parks) at the national lakeside laboratories; develop protocols for conservation and restoration of native fish species through various methods.

3.9. The Museum / Aquarium Specialist

Qualifications

A degree in biology with Post graduate experience related to museum curation and aquarium maintenance. Experience of similar work in East Africa will be an added advantage.

Duties

The museum/aquarium specialist will design and develop protocols and carry out on-job training of research scientists and technicians including collection and preservation museum curation and aquarium maintenance.

3.10. Community Participation Specialist

Qualifications

A degree in biology or social sciences with experience in fisheries extension within the East African region and preferably on Lake Victoria. This specialist should preferably come from within the East African region and should have at least 5 years experience of working with fishermen within the region.

Duties

The community participation specialist will develop protocols for community participation in conservation and sustainable use of Lake Victoria biodiversity especially fisheries.

3.11. Impact studies

Qualification

A degree in biology with Postgraduate experience related to the impact of different factors (refugia, hypoxia, exotics etc) on aquatic biodiversity. Experience under a tropical setting especially within the African Great lake's region will be an added advantage

Duties

The specialist dealing with the impacts of different factors on aquatic biodiversity will design and develop protocols in surveys aimed at obtaining information on the impact of different environmental factors especially human exploitation, introduced organisms, refugia and oxygen levels on different organisms on aquatic biodiverity in Lake Victoria and those water bodies with intimate connection to the lake and will make recommendations on how these factors should be managed to conserve biodiversity. He will carry out on-job training of research scientists and technicians including survey methods and participation in collection, analysis of the data collected and will advise and participate in compilation of information these factors together with regional counterpart scientists into a chapter to be included in the book on Biodiversity of Lake Victoria.

5.4. The expected outputs on the consultancy

Expected outputs of the study will be:

A critical mass of research scientist who will provide information on a sustainable basis of the diversity of organisms present in Lake Victoria and those water bodies with intimate connection to the lake;

a) Information on the biology especially of previously commercially important but currently scarce fish species, their biological and ecological importance, species composition, populate structure, food and feeding habits, trophic relationships, reproduction and breeding habits, growth etc;

b) Information on the diversity of flora and fauna (macrophytes, algae, invertebrates, fish, higher and other aquatic vertebrates;

c) Information on physical and biological factors affecting different organisms (human exploitation, impact of exotics, water hyacinth, refugia, oxygen levels etc;

d) Information on the genetics of major commercial / endangered species;

e) Recommendations for sustainable management of existing biodiversity and on improving stocks of endangered species;

f) Technologies for manipulation of habitats to improve and restore biodiversity;

g) Facilities and technologies for storing and archiving available diversity in museums;

h) Initiate a process whereby communities around the lake understand and are capable of conserving and sustainably utilizing existing biodiversity;

The above information will be provided in reports in the form of books, booklets, and videotapes slides e.t.c. These reports will consist of: Inception Report; Interim Report; Draft Report; and the Final Report

5.5. The inputs to be provided by the Client

The Client renders all possible assistance to ensure successful completion of the study. The Client will make available to the consultant access to all necessary documentation and information available relating to the study and the facilities needed to carry out the study. This will include:

a) Counterpart scientists and technicians in each of the riparian states
b) One vehicle from the fish biology and biodiversity sub-component without the running costs
c) Canoes, outboard motors and sampling gear
d) Laboratory space
e) Laboratory equipment and supplies
f) One desktop computer
g) One printer
h) Relevant literature available at the libraries of FIRI, TAFIRI and KMFRI

5.6 The schedule of activities and the time frame for the consultancy

6.1. Time Frame for the different consultants

Specialist	Period required during different years				
	Year 1	Year 2	Year 3	Year 4	Year 5
Fish biology and ecology			2 months	1 months	
Aquatic macrophytes			1 month	-	
Aquatic algae			1 month	0.5 months	
Aquatic invertebrates			1 months	1 months	
Fish			2 months	1 month	
Other vertebrates			1 month	1 month	
Fish genetics			2 months	1 month	
Biodiversity conservation			2 months	0.5 months	
Museum & Aquarium			0.5 months	-	
Community participation			1 month	-	
Impact studies			2 months	1 month	

6. 2. **Time Frame for different activities**

Activity	Period required during different years				
	Year 1	Year 2	Year 3	Year 4	Year 5
Development of training programme			0.5 months		
Assessment of the needs of riparian research institutions			0.5 months		
Training in Survey methodology & taxonomy:					
Fish Biology and Ecology Surveys:			2 months		
Biology of haplochromines			2 months		
Native tilapiines			2 months		
Biology of native non-cichlids			2 months		
Nile perch					
Biodiversity surveys			2 months		
Fishes			2 months	1 months	
Algae			1 month	-	
Aquatic macrophytes			1 month	1 month	
Micro-invertebrates			1 month	1 month	
Macro-invertebrates			1 month	1 month	
Other aquatic vertebrates			2 months	1 month	
Impact studies (refugia, water hyacinth, Nile perch, human exploitation, oxygen)			-	2 months	
Habitat manipulation experiments			0.5 month	0.5 month	
Preparation of taxonomic guides			2 months	2 months	
Fish genetics studies			0.5 month	-	
Development of Museum, Aquarium & marine parks			0.5 month	-	
Computer database & GIS information on biodiversity			-	0.5 month	
Development of education materials (posters, booklets, brochures, video films & slides)			1 month	-	
Development of techniques for community participation			-	1 month	1 month
Production of the book on Biology & Ecology of Fishes			-	1 month	1 month
Production of the book on Biodiversity					

-- Some of these activities may be carried concurrently by the same consultant

6.3. Completion and Submission of Reports

Reports	Date
1. Inception report	Within one month after start
2. Interim Progress Reports:	
a) First Status Reports	December 31st , 1999
b) Second Status Reports	June 30th , 2000
3. Draft Reports	December 31st, 2000
4. Final Reports	June 30th,

Please note that the above reports will consist of one or more volumes covering different outputs.

7. Contents of the Technical Proposal

This proposal should at the minimum, contain:

a) The consultants analysis of the work to be done;

b) Any basic data which is necessary to support the analysis of the work to be done or which forms the basis of the methodology proposed to conduct the study;

c) The proposed technical approach and methodology for conducting the study;

d) The proposed project staffing and management including a description of the composition and structure of the project team and how this team will be supervised;

e) Detailed estimate of requirement manpower expressed in terms of man-months broken down in individual team member and area of technical speciality;

f) Detailed work plan showing the schedule for accomplishment of the major tasks required to conduct the study;

g) Detailed curriculum vitae of the technical key experts assigned to the study.

8. Selection Criteria

The Technical evaluation of the proposal will be undertaken on the basis of the following criteria according to the weight indicated below.

	Points
i. Experience of the consultants in the assignment	15
ii. Adequacy of the proposed work plan and methodology in responding to the	
iii. Qualifications and competence of the key staff for the Assignment	25
iv. Suitability of the transfer of knowledge program (training)	20
v. Local participation (as reflected by nationals among key staff presented By foreign and local firms; maximum not to exceed 10 point)	10

Table of Contents and Authors of the Two Books as agreed during the 3rd Regional Harmonization Workshop, December 1999, Kisumu, Kenya.

(i) Biodiversity of Lake Victoria: Its Conservation and Sustainable Use

Table of Contents

7 The diversity of zooplankton in the Victoria lake basin and their relationships to ecosystem functioning and fish production. *[T: Chitamwebwa, K: Masa M., U: Ndawula L.M.]*

8 The diversity of macro-invertebrate in the Victoria lake basin and their relationship to ecosystem functioning and fish production. *[T: Mwambungu, K: Muli J., U: Twongo T.K.]*

9 Fish species diversity in the Victoria lake basins, their conservation and sustainable use *[T: Chande, K: Ogari J., U:Namulemo G.;]*

10 The diversity of amphibians, reptiles and aquatic mammals and their importance in the Victoria lake basin. *[T: Howell, K: Boera P., U: Behangana M.]*

11 The diversity of aquatic birds and their relationship to aquatic ecosystems in the Victoria Lake basin. *[T: Mlingwa, K: Boera P., U: Arineitwe.]*

12 Genetic status of selected fish species in relation to conservation of genetic and species diversity in the Victoria lake basin *[T: Mwaiko, K: Boera P., Mwanja W.]*

13 Biodiversity values of different aquatic eco-systems, habitats and organisms in relation to restoration and sustaining of fish species diversity *[T; Jomme, K: Jembe J., U: Mbabazi D.]*

Appendices: List of algae, aquatic macrophytes, invertebrates, fish, birds, amphibians, reptiles, mammals encountered by water body. *[T: Jomme, K: Muli J., U: Mbabazi]*

(ii) The Biology And Ecology of Lake Victoria Fishes: Their Development And Management

Table of contents

8 The biology and ecology of surviving haplochromines in aquatic ecosystems of the Victoria Lake basin *[T: None, K: Ojwang, U: Namulemo G.]*

9 Trophic interrelationships and food –webs among fishes in the Victoria basins *[T: Chitamweba, K: Monica O., U: Mbabazi D.,]*

10 The consequences of using different mesh sizes of gillnets on the fisheries and on biodiversity of Lake Victoria fishes *[T: Bayona, K:Asila, Ogutu-Ohwayo R.]*

11 Management of the fishes and fisheries of the Victoria Lake basin *[T: Chande, K: Getabu A., Kibwika D.]*

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

TELEPHONE: KISUMU 40126/40129
E - mail: kmfrims@lib.ui.ac.be
When replying please quote
Ref. No KMF/. KMF/GEF/LVEMP/RS/51.II/192
and Date
If calling or telephoning ask
for. DR. WAKWABI
please address your reply to
DEPUTY DIRECTOR

KISUMU STATION
P.O BOX 81881
KISUMU
KENYA

Date: 25th July, 2001

Dr. Lucas Ndawula
Task Coordinator
LVEMP Fish Biology and Biodiversity Conservation
Fisheries Resources Research Institute (FIRRI)
P o Box 343
Jinja- UGANDA.

Mr. Egid F. Katunzi
Centre Director/Task Coordinator
LVEMP Fish Biology & Biodiversity Conservation
Tanzania Fisheries Research Institute (TAFIRI)
P O Box 475
Mwanza- TANZANIA.

RE: PROCEEDINGS OF THE REGIONAL WORKSHOP ON HARMINIZATION OF TERMS OF REFERENCES (TOR's) FOR REGIONAL CONSULTANCY ON FISH BIOLOGY AND BIODIVERSITY CONSERVATION

Enclosed please, find a copy of the above proceedings and a copy of the letter sent to the three Secretariats submitting the same.

I am forwarding the same to you so that you can follow-up the matter with your component Coordinator and National/Regional Secretariats to start off processes to meet the proposed way forward in the proceedings.

With regards.

Dr. E. Wakwabi
Regional Coordinator
LVEMP FISH BIOLOGY AND BIODIVERSITY CONSERVATION

6 AUG 2001

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

TELEPHONE: KISUMU 40126/ 40129
E - mail: kmfrims@lib.ui.ac.be
When replying please quote
Ref. No KMF/KSM/GEF/LVEMP/RS/51 II/187
and Date
If calling or telephoning ask
for. DR. WAKWABI
please address your reply to
DEPUTY DIRECTOR

KISUMU STATION
P.O BOX 81881
KISUMU
KENYA

12TH JULY 2001
Date: .....

Mr .C Nyirabu
Regional Executive Secretary
LVEMP
P.O. BOX 78089-Dar-es-Salaam
TANZANIA

Prof. J. B.Ojiambo
National Executive Secretary
LVEMP
P.O. BOX 30126-Nairobi
KENYA

Attn. Dr. Ndawula

For your information and follow-up on issues raised in the proceedings

25.7.2001

Dr. Orach Meza
National Executive Secretary
LVEMP
P.O. BOX 5 - **Jinja**
UGANDA

RE: PROCEEDINGS OF THE REGIONAL WORKSHOP ON HARMONIZATION OF TERMS OF REFERENCES (TOR's)FOR REGIONAL CONSULTANCY ON FISH BIOLOGY & BIODIVERSITY CONSERVATION:

A regional workshop for the Fish Biology and Biodiversity Conservation Sub Component (LVEMP) was held at FIRRI, Jinja (Uganda) on 29th - 30th May 2001. The proceedings of this workshop is hereby forwarded to you for your noting and further action.

A number of recommendations were made for the way forward especially on the planned regional activities:

1. Sampling of satellite lakes;
2 Trans-border sampling.
3. Regional consultancies; and

4. Preparation of the two text books on Lake Victoria i.e. the biology and ecology of Lake Victoria fishes. Their development and Management; and Biodiversity of Lake Victoria - its Conservation and Sustainable use.

As a follow-up to these recommendation, the Sub-Component through their respective Component will be coming up with activity plans and programs for your approvals. This was agreed as the way forward for the component to achieve the LVEMP projected Regional and National objectives for this sub-component.

This is therefore to further request you to consider and facilitate these planned activities.

Dr. E.O. Wakwabi
Regional Sub-Component Coordinator
Fish Biology & Biodiversity Conservation LVEMP.

C.C
Dr. R. Ogutu-Ohwayo*
Director FIRRI,
Fisheries Research Component Coordinator
P.O. BOX 343 **Jinja**
UGANDA

Prof. P. Bwathondi *
Director General- TAFIRI,
Fisheries Research Component Coordinator
P.O. BOX 9750-**Dar-es-Salaam**
TANZANIA
***Please, communicate this information to your Task Coordinator.**

Dr. J. M. Kazungu
The Director,
KMFRI
P.O BOX 81651, **Mombasa**

Forty one haplochromine species from the sampled lakes were examined for food out of which 24 species contained food material. Overall, seven food categories were identified from the stomach contents. These included detritus, algae, higher plant material, insects, molluscs, fish eggs and fish remains. Kyoga basin haplochromines therefore comprised 7 trophic groups.The trophic groups in order of abundance by species were insectivores (8), peadophages (6), piscivores (4), algal eaters (4), higher plant eaters (1), molluscivore (1) and detritivores (1). The haplochromine species whose trophic groups were unknown were (17). In Lake Kyoga main trophic groups were insectivores (7) and molluscivores (1). The percentage contribution by number of species for different lakes is shown in Fig. 4. The haplochromines whose trophic groups were unknown were (5).

Comparison of diversity by number of species and trophic diversity by Shannon Weaver index (H') between different lakes is illustrated in figure 5. Basing on number of species, highest in Lake Nawampasa (29), followed by lakes Gigati (26), Kawi (20), Agu (17), Nyaguo (16), Kyoga (15) and was lowest in Lake Lemwa (12). Basing on Shannon Weaver index (H'), trophic diversity was highest in Lake Nawampasa (1.28), followed by lakes Gigati (1.25), Kawi (1.18), Agu (0.89), Lemwa (0.81), Nyaguo (0.35) and was lowest in Lake Kyoga (0.13). Overall, the minor lakes (1.49), had higher trophic diversity than the main lake (0.13).

Trophic diversity by number of trophic groups was highest in lakes Nawampasa, Gigati, Agu, and Kawi (5), followed by Nyaguo and Lemwa (3) and the lowest number was recorded in Lake Kyoga main (2).

Transfer of energy by haplochromines basing on the proportion by number of primary, secondary and tertiary consumers among haplochromines in each lake is illustrated (Figure 6). Lake Lemwa was dominated by secondary consumers followed by primary consumers and very few tertiary consumers. Lake Kawi had no primary consumers and was, like Lake Lemwa dominated by secondary consumers. Lake Agu had no secondary consumers was dominated by primary consumers. Lake Nyaguo had no primary consumers but had almost equal proportions of secondary and tertiary consumers. Lake Gigati was dominated by primary consumers, Lake Nawampasa had almost equal proportions of secondary and primary consumers. Overall, Kyoga Minor lakes were dominated by primary consumers followed by almost equal proportions of secondary and tertiary consumers. Lake Kyoga had only secondary consumers.

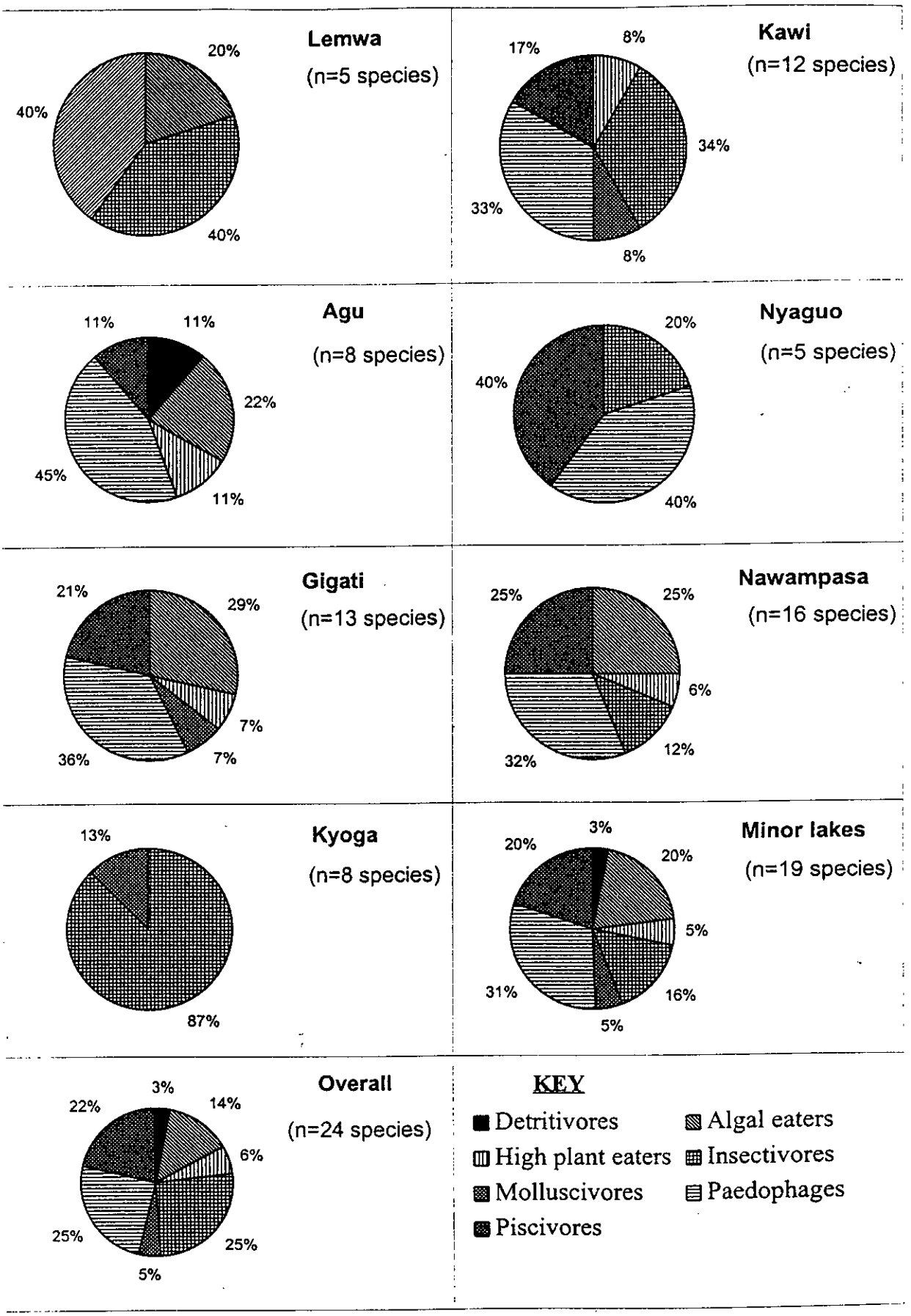


Fig. 4 Overall percentage contribution of trophic groups by species of haplochromines from Kyoga lake basin

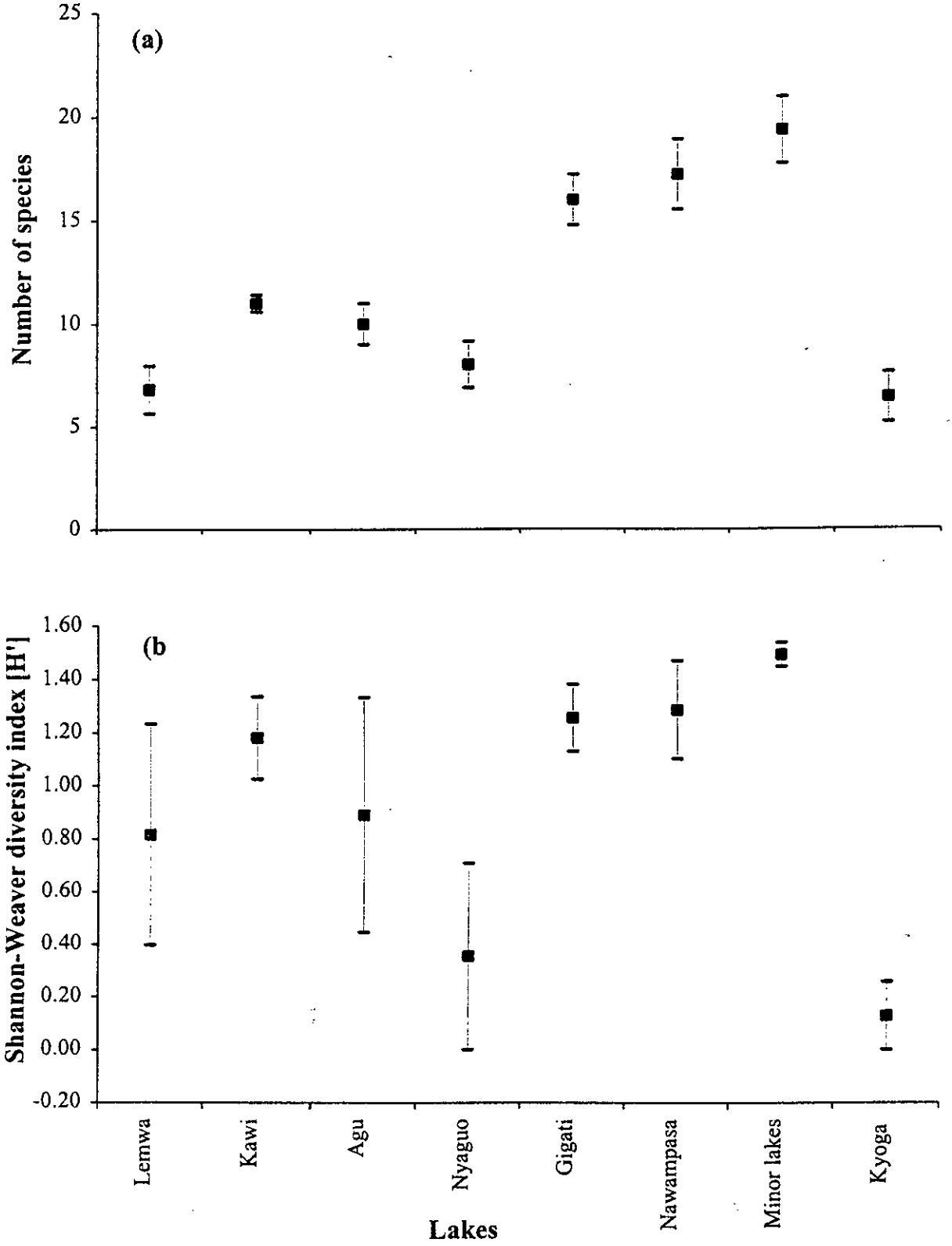
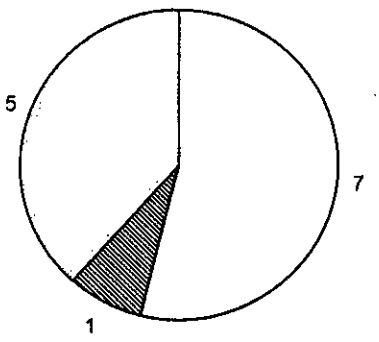


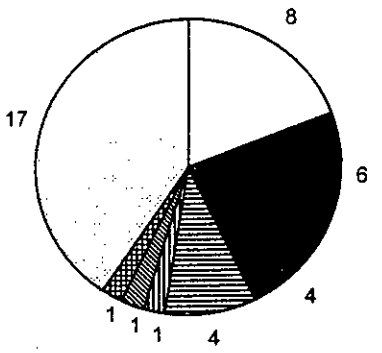
Fig. 5 Comparison of number of Species of haplochromines (a) and Shannon-Weaver indices of diversity[H'] (b) of trophic groups between lakes. Vertical bars reperesent lower critical limits ($p<0.05$).

Lake Kyoga main 1997/1998



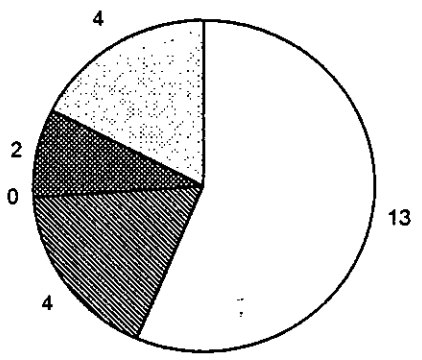
- Insectivores
- Molluscivores
- Unknown

Overall Kyoga lake basin 1997/1998



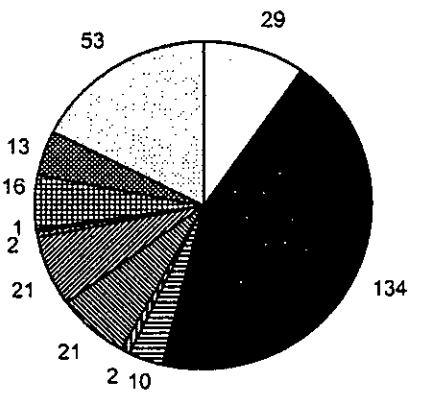
- Insectivores
- Peadophages
- Piscivores
- Algae eaters
- Higher plant eaters
- Molluscivores
- Detritivores
- Unknown

Lake Victoria 1995/1996 (Namulemo, 1997)



- Insectivores
- Molluscivores
- Prawn eaters
- Unknown

Lake Victoria 1984 (Goldschmidt, 1996)



- Insectivores
- Peadophages
- Piscivores
- Algae eaters
- Higher plant eaters
- Molluscivores
- Zooplanktivores
- Parasite eaters
- Crab eaters
- Detritivores
- Prawn eaters
- Unknown

Fig. 7 Comparison of number of haplochromine trophic groups from Lake Victoria and Kyoga lake basins.

Haplochromines feed on a broad range of food items. This factor, more than any other, may have contributed to proliferation of these fish in lakes where they are found as it ensures maximum utilization of the food resources (Fryer, 1969). In Lake Victoria, haplochromines have undergone extensive adaptive radiation to produce about 300 species. Speciation is largely reflected in the feeding habits with adaptations for feeding on all possible foods. In Lake Victoria it is usual for more than one haplochromine species to occupy the same niche in the same habitat.

Conclusion

The present study has shown that many haplochromine trophic groups which existed in lakes Victoria and Kyoga prior to the Nile perch introductions and whose stocks were reduced these lakes are present in the Kyoga Minor lakes. The study may also provide a picture of the trophic structure of haplochromines that existed in Lake Kyoga before Nile perch upsurge. The presence of Nile perch in Lake Kyoga has simplified the trophic structure of haplochromines in the lake from seven trophic groups to two. The Kyoga Minor lakes therefore provide a great opportunity for conservation of fish species diversity threatened by introduction of exotics and other anthropogenic impacts in the Victoria and Kyoga lake basins.

It is therefore recommended that;

a) Some of the Kyoga minor lakes like Nawampasa, Gigati, Kawi and Agu be designated as conservation areas of haplochromines and other species threatened by introduction of exotics in lakes Victoria and main lake Kyoga.

b) Clearing of swamps and vegetation that separate Kyoga Minor lakes from the main lake be avoided to prevent the spread of Nile perch into these lakes. This is because presence of extensive swamps around these lakes is one of the factors that has prevented Nile perch from colonising minor lakes.

c) There is need for a more detailed study on the trophic ecology to include the other fishes in these lakes in order to answer the question of how energy is channelled through the different systems.

References

Graham, M. 1929. *The Victoria Nyanza and its fisheries*. A report of the survey of Lake Victoria 1927-1928 and Appendices. Crown Agents for colonies. 225pp.

Greenwood, P.H. 1965. The cichlid fishes of Lake Nabugabo, Uganda. *Bulletin of the British Museum of Natural History (Zoology)* 12 (9): 313-357.

Greenwood, P.H. 1966. *The fishes of Uganda*. The Uganda society, Kampala. (2nd edition)

Hynes, H.B.N. 1950. The food of the freshwater sticklebacks (*Gasterosteus escleatus* and *Pygosteus pungitius*) with a review of methods used in the food of fishes. *J. Anim. Ecol.* 19: 36-58.

Jackson, P.B.N., 1971. The African Great Lakes fisheries: past, present and future. *Afr. J. Trop. Hydrobiol. Fish.* 1: 45-54.

Kudhongania, A.W & A.J. Cordone 1974. Batho-spatial distribution pattern and biomass estimate of the major demersal fishes in Lake Victoria. *Afr. J. trop.Hydrobiol. Fish.* 3: 15-31.

Ligtvoet, W. & O.C. Mkumbo 1990. Effects of changes in fish populations in Lake Victoria on the food of otters in (*Lutra maculicollis* Schinz and *Aonyx capensis* Lichtenstein). *Afr. J. Ecol.* 28:322-329.

Ligtvoet, W. & O.C. Mkumbo 1990. Stock assessment of Nile perch in Lake Victoria. FAO Fish. Rep., no.430. 35-74.

Lowe- Mc Connell, R.H. 1987. Ecological studies in tropical fish communities. University Press, Cambridge. 76pp.

Ochumba, P.B.O. & D.I. Kibara 1989. Observations on blue green algal blooms in open waters of lake Victoria, Kenya. *African Journal of Ecology* 27: 23-34.

Ogari, J. & S. Dadzie 1988. The food of the Nile perch, *Lates niloticus* (L.) after disappearance of the haplochromine cichlids in the Nyanza Gulf of Lake Victoria (Kenya). *J. Fish. Biol.*, 32: 571-577.

Ogutu-Ohwayo, R. 1990a. The decline of the native fishes of Lakes Victoria and Kyoga (East Africa) and the impact of introduced species, especially the Nile perch, *Lates niloticus* and the Nile tilapia, *Oreochromis niloticus*. *Environmental Biology and Fisheries*, 27: 31-96.

Ogutu-Ohwayo, R. 1990c. The reduction in fish species in Lakes Victoria and Kyoga (East Africa) following human exploitation and introduction of non-native fishes. *J. fish. Biol.*, 37 (Suppl.A), 207-8.

Ogutu-Ohwayo, R. & R.E. Hecky 1991. Fish introductions in Africa and some of their implications. *Can. J. Fish. Aquat. Sci* 48 (Suppl. 1): 8-12.

Trewavas, E., 1933. Scientific results of Cambridge expedition to the East African lakes, 1930. 1-11. The cichlid fishes. *J. Linn. Soc. Lond.* 38:309-341.

Witte, F.,T.Goldschmidt, K.Goudswaard, W. Ligtvoet, M.J.P. Oijen & J.H. Wanink. 1992a. Species extinction and concomitant ecological changes in LakeVictoria. *Neth. J. Zool.* 42:214-232.

Witte, F., Goldschmidt, K.Goudswaard, W. Ligtvoet, M.J.P. Oijen & J.H.Wanik 1992b. The destruction of an endemic species flock: quantitative data on the decline of haplochromine cichlids of Lake Victoria. *Env. Biol. Fish.* 34: 1-28.

Worthington, E.B. 1929. A report on the fishing survey of lakes Albert and Kyoga. Crown Agents for the colonies. London. 136 pp.

Worthington, E.B. 1932. A report on the fisheries of Uganda. Crown Agents for the colonies. London. 95pp.

CHAPTER 9

Trophic Interrelationships and Food-Webs among the Fishes in Ecosystems of the Victoria and Kyoga Lake Basin.

Mbabazi D., R. Ogutu-Ohwayo, S.B Wandera and G. Namulemo
Fisheries Research Institute,
P.O.Box 343,
Jinja

Abstact

The Victoria and Kyoga lake basins had a high fish species diversity with many fish species that were found only in these lakes. Two Tilapiines species *Oreochromis esculentus* and *Oreochromis variabilis* were the most important commercial species in these lakes and were found nowhere else on earth except in the Victoria and Kyoga lake basins (Graham 1929, Worthington 1929). Lakes Kyoga and Nabugabo also had endemic haplochromine species (Worthington 1929, Trewavas 1933, Greenwood 1965, 1966). As stocks of introduced species increased, stocks of most of the native species declined rapidly or disappeared altogether. The study was carried out on Lakes Victoria and Kyoga, River Nile, some selected satellite lakes from the two basins namely Lakes Mburo, Kachera, Wamala, Kayanja, Kayugi, Nabugabo, Victoria, Victoria nile and River Sio(Victoria lake basin). Lakes Kyoga (Iyingo), Nawampasa, Nakuwa, Gigati, Nyaguo, Agu, Kawi and Lemwa (Kyoga lake basin).

Species composition and relative abundance of fishes were estimated by determining the overall average total number of each species encountered. A trophic consists of species using the same food category. Shannon-Weaver Index of diversity H' (Pielou, 1969) and number of trophic groups, were used to estimate the Trophic diversity of various fish species in the lakes. Food analysis has been done on some fishes in some of the sampled lakes and is still going on, on remaining fishes and in some lakes.

Generally fish ingested detritus, *Spirulina*, *Melosira*, filamentous algae, *Planktolyngbya*, *Microcysists*, *Anabaena*, *Merismopedia*, *Spirogyra*, higher plant material, rotifers, Ostracodes, Chironomid larvae and pupae, Choaborus larvae, *Odonata*, *Povilla*, Insect remains, *Caridina*, fish eggs and fish. Eight trophic groups were identified from thes food items ingestes. These included detritivores, algae eaters, higher plant eaters, zooplanktivores, insectivores, molluscivores, prawn eaters, paedophages and piscivores.
Trophic diversity by number of trophic groups was highest in Lake Kyoga (6) followed by lakes Kayugi, Nabugabo, River Nile and Mburo (3) and the lowest number was recorded in kachera (2).

Back ground

The Victoria and Kyoga lake basins had a high fish species diversity with many fish species that were found only in these lakes. Two Tilapiines species *Oreochromis esculentus* and *Oreochromis variabilis* were the most important commercial species in these lakes and were found nowhere else on earth except in the Victoria and Kyoga lake basins (Graham 1929, Worthington 1929). Many other species, such as *Protopterus aethiopicus*, *Bagrus docmac*, *Clarias gariepinus*, *Barbus spp*, mormyrids, *Synodontis* spp, *Schilbe intermedius* and

Rastrineobola argentea, were also abundant (Graham 1929, Worthington 1929, 1932a, Kudhongania & Cordone 1974). The rivers of the Victoria lake basin had a number of riverine species the most commercially important of which were *Labeo victorianus* and *Barbus altianalis*. Lake Victoria contained over 300 species belonging to one group the haplochromine cichlids over 99% of which were endemic (Witte et al. 1992 a, b). Lakes Kyoga and Nabugabo also had endemic haplochromine species (Worthington 1929, Trewavas 1933, Greenwood 1965, 1966). The fishes occupied virtually all trophic levels and played an important role in the flow of organic matter and overall ecological efficiency of these lakes. The fishes were important as human food and provided outstanding opportunities for studying evolutionary processes and community ecology (Lowe- Mc Connell, 1987).

By the 1960's, stocks of the native tilapiines and other large species of Lake Victoria had been reduced by overfishing (Jackson 1971, Ogutu-Ohwayo 1990a). Nile perch and four tilapiine species were introduced into many of the lakes in the basin, including lakes Victoria and Kyoga in 1950's and early 1960's to improve stocks of the declining fishery. As stocks of introduced species increased, stocks of most of the native species declined rapidly or disappeared altogether. Of the more than 300 native species, only *Rastrineobola argentea* (Mukene) remained abundant (Ogutu-Ohwayo 1990c). Haplochromines dropped from about 80% of the fish biomass in Lake Victoria in 1970s to less than 1% in 1980s, and about 200 species are feared to have become extinct. These haplochromines were important as food and were of medical, scientific and ecological value. They occupied all trophic levels and played a major role in the flow of energy in the ecosystem. They were crucial in maintaining the ecosystem that supported other food fishes, as well as the high biodiversity associated with the lake basin. Studies of haplochromines played a major role in illustrating how organisms undergo adaptive radiation to produce new species, and how a trophically diverse assemblage can efficiently utilize an ecosystem.

As a result of overfishing and introduction of exotic fishes, populations of most of the native species declined and many species became extinct (Witte et al. 1992 a, b). The original decline in fish stocks was due to overfishing (Jackson 1971, Ogutu - Ohwayo 1990 a) but the recent and more drastic decline has been due to predation by the introduced Nile perch and overall environmental degradation (Ogari & Dadzie 1988, Ligtvoet & Mkumbo 1990, Ogutu - Ohwayo 1990 b, Witte et al. 1992 a, b).

The loss of species and trophic diversity, and associated alterations in food webs have been accompanied by more frequent algal blooms and deoxygenation of the hypolimnion, which sometimes have been associated with mass fish kills in Lake Victoria (Ochumba & Kibara 1989). The accumulation of the excess organic matter is an indication that much of the organic matter produced in the lake is not being channelled efficiently through the food web. The native fishes had occupied virtually all trophic levels, including phytoplanktivores, zooplanktivores, insectivores, molluscivores, detritivores, piscivores and maintained an efficient flow of organic matter in the system. The depletion in stocks of this trophically diverse fish community by Nile perch changed the food web of the lake and seems to have reduced grazing pressure and the overall ecological efficiency of the ecosystem in the lakes.

Study Objectives

The overall objective of this study was to rectify the serious lack of knowledge on trophic ecology in the Victoria and Kyoga lake basins. This was achieved by specifically examining, species composition of fishes, the food and trophic diversity of fishes in the different lakes in the Victoria and Kyoga lake basins and how this compares between lakes and with lakes Victoria and Kyoga.

Study Area, Materials and Methods

Study Area

The study was carried out on Lakes Victoria and Kyoga, River Nile, some selected satellite lakes from the two basins namely Lakes Mburo, Kachera, Wamala, Kayanja, Kayugi, Nabugabo, Victoria, Victoria nile and River Sio(Victoria lake basin). Lakes Kyoga (Iyingo), Nawampasa, Nakuwa, Gigati, Nyaguo, Agu, Kawi and Lemwa (Kyoga lake basin). Figs

Materials and Methods

Fish were collected using experimental gill nets, locally constructed basket traps sometimes from commercial catches. Three fleets of gill nets were set at one selected station at various distances from the shore line to the open water on every small lake and some three or four selected stations on the bigger lakes. On retrieval fish were sorted into their taxonomic groups to species level whenever possible and the number and weight of each taxa recorded. The bigger fishes were cut open, their stomachs dissected out and their degree of fullness determined as 1(full), 3/4, 1/2, 1/4, <1/4 or 0 (empty). The stomachs were labelled and preserved for later laboratory analysis. The fishes not identified in the field especially haplochromines were preserved in 10% formaldehyde solution, labelled with date and habitat of capture and transported to Fisheries Research Institute (FIRI) laboratory where further identifications and food analysis were done.

In the laboratory fishes not identified in the field were sorted into taxonomic groups to genus or species level where possible. If a fish could not exactly fit the described characters it was assigned a "chieronym". Morphological characteristics of small fishes were examined with the help of a binocular microscope. The species that were not identified in the laboratory were compared with specimens of described species present in FIRI museum.
The preserved fishes were treated as follows: -
The fish were cut open, the stomach of each fish dissected out and its degree of fullness determined. Both the preserved stomachs and those got from the preserved fish were slit open and the contents emptied on to a petri dish, flooded with water and examined first under a binocular microscope and later on a slide under a compound microscope. The food items were sorted and identified as far as possible and estimated as percentage through judgement by eye. The percentages were then allotted points 0, 1, 2, 4, 8 and 16 depending on the relative importance of the food item in the stomach according to Hynes (1950).

Species composition and relative abundance of fishes were estimated by determining the overall average total number of each species encountered. The percentage contribution by number of each species were calculated by dividing the total number of each species by the total number of all the species, multiplied by 100. The data were presented in tabular form. The food items were classified into related groups and the dominant food category was taken as decisive of the Trophic classification (Witte, 1981). A trophic consists of species using the same food category. Shannon-Weaver Index of diversity H' (Pielou, 1969) and number of trophic groups, were used to estimate the Trophic diversity of various fish species in the lakes.

Results

Food analysis has been done on some fishes in some of the sampled lakes and is still going on, on remaining fishes and in some lakes.

Mburo

Overall nine fish species, five non-haplochromines and four haplochromines were encountered in Lake Mburo. The non-haplochromines included *Oreochromis esculentus*, *Oreochromis niloticus*, *Oreochromis leucostictus*, *Clarias gariepinus* and *Protopterus aethiopicus*. The haplochromines included *Harpagochromis squamipinus*, *Astatotilapia nubila*, *Astatotilapia aeneocolor*, and *Astatorechromis alluaudii*. Out of these species only four non haplochromine species have been examined and contained food contents. These included *O. leucostictus*, *C. gariepinus*,*O. niloticus* and *P. aethiopicus* (Fig. 3).

Kachera

Overall twelve fish species, seven non-haplochromines and four haplochromines were encountered in Lake Kachera. The non-haplochromines included *Oreochromis esculentus*, *Oreochromis leucostictus*, *Oreochromis niloticus*, *Protopterus aethiopicus*, *Clarias gariepinus*, *Clarias liocephalus* and *Tilapia zillii*. The haplochromines included *Harpagochromis squamipinus*, *Astatotilapia nubila*, *Astatotilapia* spp and *Astatorechromis alluaudii*. Out of these species only four non haplochromine species have been examined and contained food contents. These included *O. leucostictus*, *O. esculentus*, *C. gariepinus* and *O. niloticus* (Fig. 4).

Kayugi

Overall eleven fish species, six non-haplochromines and five haplochromines were encountered in Lake Kayugi. The non-haplochromines included *Brycinus sadleri*, *Barbus kersterni*, *Gnathonemus victoriae*, *Oreochromis esculentus*, *Petrocephalus catastoma*, and *Protopterus aethiopicus*. The haplochromines included *Astatotilapia velifer*, *Astatotilapia nubila*, *Gaurochromis simpsoni*, *Astatorechromis alluaudii* and *Prognathochromis venator*. Out of these species only five non haplochromine species have been examined and contained food contents. These included *O. esculentus*, *O. leucostictus*, *G. victoriae*, *C. gariepinus*, and *P. aethiopicus* (Fig. 5).

Nabugabo

Overall sixteen fish species, twelve non-haplochromines and four haplochromines were encountered in Lake Nabugabo. The non-haplochromines included *Brycinus sadleri*, *Barbus kersterni*, *Gnathonemus longibarbis*, *L. niloticus*, *Mercusenius grahami*, *O. rendalli*, *O. leucostictus*, *O. niloticus*, *P. aethiopicus*, *Schilbe intermedius*, *Synodontis afrofischeri* and *T. zillii*. The haplochromines included *Astatotilapia velifer*, *Astatotilapia nubila*, *Gaurochromis simpsoni*, *Astatorechromis alluaudii* and *Prognathochromis venator*. Out of these species only seven non haplochromine species have been examined and contained food contents. These included *O. esculentus*, *O. leucostictus*, *G. victoriae*, *C. gariepinus* and *P. aethiopicus* (Fig. 6).

Victoria Nile

Overall six non-haplochromines and some haplochromines were encountered in Victoria Nile. The non-haplochromines *included M. kannume*, *L. niloticus*, *B. altianalis*, *O. niloticus* and *T. Zillii*. Out of these species only three non haplochromine species have been examined and contained food contents. These included *L. niloticus*, *O. niloticus* and *M. kannume* (Fig. 7).

River Sio

Overall fourteen non-haplochromines and one genus of haplochromines were encountered in Victoria Nile. The non-haplochromines included *M. Grahami*, *Barbus jacksonii*, *B. Sadleri*, *S. Victoriae*, *L. niloticus*, *S. afrofischeri*, *Brycinus jacksonii*, *C. gariepinus*, *S. intermedius*, *O. Leucostictus*, *O. niloticus*, *L. victorianus* and *G. Longbarbis*. The haplochromines encountered were of *Ptyochromis spp*. None of these species has been examined for food.

Kyoga

Overall thirty two fish species, eighteen non-haplochromines and fourteen haplochromines were encountered in Lake Kyoga. The non-haplochromines included *L. niloticus*, *Brycinus sadleri*, *Gnathonemus victoriae*, *O. niloticus*, *S. victoriae*, *Synodontis afrofischeri*, *Mormyrus macrocephalus*, *T. zillii*, *O. leucostictus*, *Schilbe intermedius*, *P. aethiopicus*, *Clarias gariepinus*, *Labeo victorianus*, *G. longibarbis*, *B. altianalis*, *P. catastoma* and *Mormyrus kannume*. The haplochromines included *Paralabidochromis "blackpara"*, *Astatotilapia nubila*, *Pssamochromis "shovelmouth"*, *Astatotilapia "kyogaastato"*, *Xystichromis "flameback"*, *Paralabidochromis "earthquake"*, *Prognathochromis guiarti*, *Yssichromis kyogazooplanktivore*, *Xystichromis phytophagus*, *A. alluaudi*, *Lipochromis parvidens*, *Lipochromis "blackcryptodon"*, *Haplochromis lividus* and *Gaurochromis* spp. Out of these species only six non haplochromine species and eight haplochromine species have been examined and contained food contents. These included *L. niloticus*, *B. altianalis*, *Mercusenius grahami*, *P. aethiopicus*, *S. victoriae and S. intermedius*. (Fig. 8). The haplochromines included *P. "blackpara"*, *A. nubila*, *P. "shovelmouth"*, *A. "kyogaastato"*, *X. "flameback"*, *P. "earthquake"*, *Y. kyogazooplanktivore*, *X. phytophagus* and *A. alluaudi*.

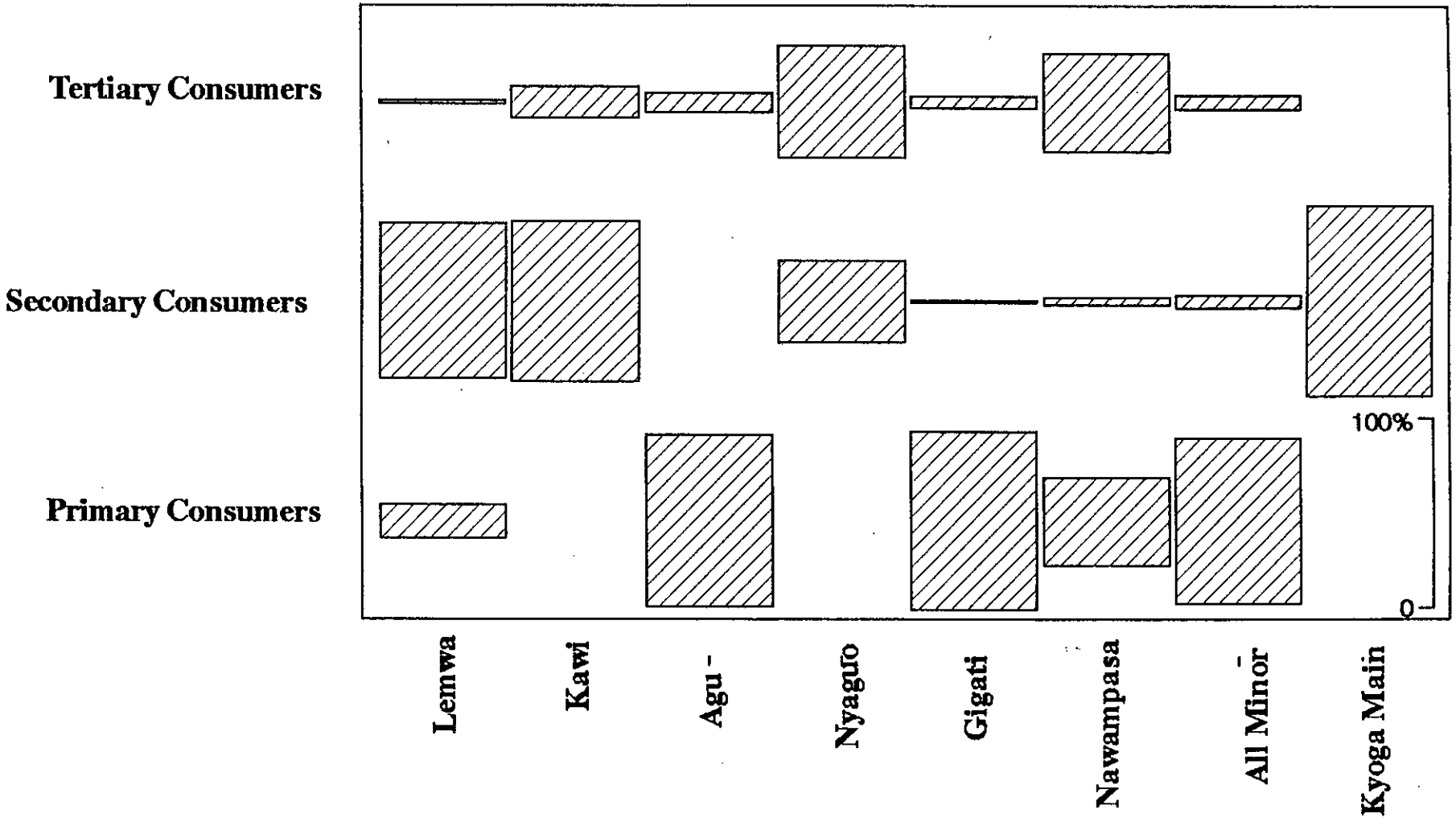


Fig 6 The percentage contribution by number of haplochromines at different trophic levels in different lakes of Kyoga Lake Basin

- So far results obtained indicate that generally fish ingested detritus, *Spirulina*, *Melosira*, filamentous algae, *Planktolyngbya*, *Microcysists*, *Anabaena*, *Merismopedia*, *Spirogyra*, higher plant material, rotifers, Ostracodes, Chironomid larvae and pupae, Choaborus larvae, *Odonata*, *Povilla*, Insect remains, *Caridina*, fish eggs and fish. These food items were grouped into 8 categories for purposes of trophic classification. These included detritus, algae, higher plant material, zooplankton, insects, molluscs, prawns, fish eggs and fish. The percentage contribution of food categories in diet of different fishes in different lakes (Figs 3, 4, 5, 6, 7, 8 and 9 .